The Scientific Challenges of Carbon Sequestration

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Purposeful carbon sequestration has rapidly emerged as a third strategy for mitigating the buildup of green house gases in the atmosphere. Purposeful carbon sequestration involves two elements: (1) the capture of CO_2 both from the atmosphere and from concentrated sources such as fossil-fuel-fired power plant emissions, and (2) the long-term storage of captured carbon in forms or places which prevent rapid return to the atmosphere. The terrestrial biosphere, oceans and deep geologic formations have all been suggested as promising options for the long-term storage of CO_2. In comparison to the other two strategies for mitigating the buildup of greenhouse gases, namely, increasing energy efficiency and switching to fuels with lower net carbon emissions, the science of carbon sequestration is new and expanding rapidly. Significant issues regarding the effectiveness and environmental consequences of all these options need to be addressed to determine which holds the most promise and how they may safely contribute to addressing greenhouse gas issues.

The U.S. Department of Energy (DOE) has created a number of new fundamental and applied research programs to address these issues, including collaborative efforts that bring together multi-disciplinary teams to systematically identify and address the most challenging issues. DOE's Office of Science has established two centers at the DOE Laboratories to build the scientific foundations for evaluating the effectiveness and environmental consequences of purposeful sequestration: CSITE for studying terrestrial biosphere options and DOCS for studying ocean sequestration options. DOE's Office of Fossil Energy has initiated the GEO-SEQ Project, a public-private partnership for evaluating and enhancing geologic sequestration options. This paper highlights the critical scientific challenges in each of these areas and presents early progress towards addressing them.